12.—Origin of Glauconite in some Sandstones of the Plantagenet Beds, Cheyne Bay, Western Australia

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The spicular sandstones of the Plantagenet Beds are composed mainly of quartz, glauconite, sponge spicules and opaline cement. Much of the glauconite is associated with muscovite and all variations between pure muscovite, muscovite with incipient developments of glauconite, and pure glauconite can be seen. X-ray powder patterns of the pure "end members" show that they are structurally very similar. Studies of the vertical variation of percentage composition of the rocks suggest that at least some of the glauconite of the sandstones has formed from muscovite, probably during early diagenesis.

Introduction

Various theories of origin have been postulated for glauconite. It has been suggested that glauconite forms from mud, especially in the presence of organic matter (Murray and Renard 1891), from coprolites (Takahashi and Yagi 1929), from the flocculation of colloidal solutions (Hadding 1932) and from biotite (Galliher 1935, 1939). Much of the extensive literature on the subject is listed in bibliographies by Cloud (1955) and Wermund (1961). The following short paper describes the occurrence and probable origin of glauconite in the Eocene Plantagenet Beds at Cheyne Bay, Western Australia.

Discussion

The Plantagenet Beds were described by Clarke and Phillipps (1955) and more recently have been the subject of investigation near Cheyne Bay by Hodgson, Quilty and Rutledge (1962). At Cheyne Bay, they are represented by at least 250 feet of well-banded, glauconite-bearing, spicular sandstone. The banded nature of the rocks is due to the alternation of hard spicular opal-rich layers and softer less siliceous ones. Mineralogically the spicular sandstones are simple, being composed almost entirely of quartz, sponge spicules (and associated opaline cement) and glauconite with minor amounts of muscovite, clay minerals, magnetite and pyrite.

The sandstones rarely contain more than 10 per cent. glauconite and the amount seems unrelated to the hardness of the rocks in which it is found. The glauconite generally occurs either as minute (0.05 mm) globules associated with muscovite, or as small rounded aggregates between 0.1 mm and 0.05 mm across. The latter frequently contain remnants of muscovite. Foraminiferal tests infilled with glauconite are not commonly found in these rocks.

In reflected light the glauconite is olive-green but is a somewhat lighter colour in transmitted light. Where limonitization is advanced the colour becomes yellowish. Since the individual crystals are extremely small and are randomly oriented, the grains show no pleochroism and only aggregate birefringence. Accordingly the refractive indices cannot be determined precisely, but fall within the range between 1.615 and 1.630.

From grain mounts of the "lights" of the spicular sandstone, it is possible to select a series of specimens ranging from glauconite-impregnated muscovite to almost pure glauconite. Apparently at least some of the glauconite in the rocks has formed from muscovite. A comparatively early stage in the formation of glauconite from muscovite is represented by grains of the latter in which glauconite globules occur along the 001 cleavage planes around the edges of the flake (Fig. 1). Where glauconitization is slightly more advanced, the developing globules can be seen throughout the muscovite flake. An even later stage is represented by almost pure glauconite grains which have a micaceous habit. No doubt much of the glauconite which now shows no feature relating it to muscovite, has been derived from this mineral.

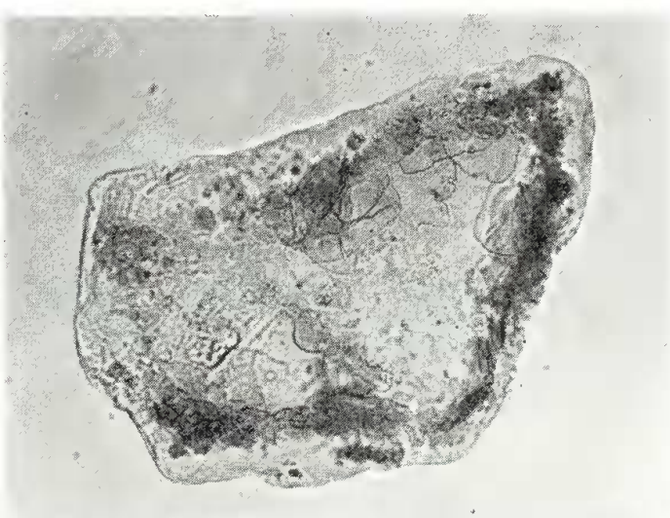

Fig. 1.—Muscovite flake from U.W.A. Specimen 46759. Plane polarized light. Glauconite is developing along the 001 cleavage planes around the periphery of the flake. Width of field of view 0.15 mm.

Supporting the theory of biotite-glauconite transformation, Galliher (1939) cited the presence of reaction structures in the biotite of the sediments of Monterey Bay, California. In addition he mentioned the work of Gruner (1935) which, using X-ray powder patterns, showed that glauconite was structurally related to the

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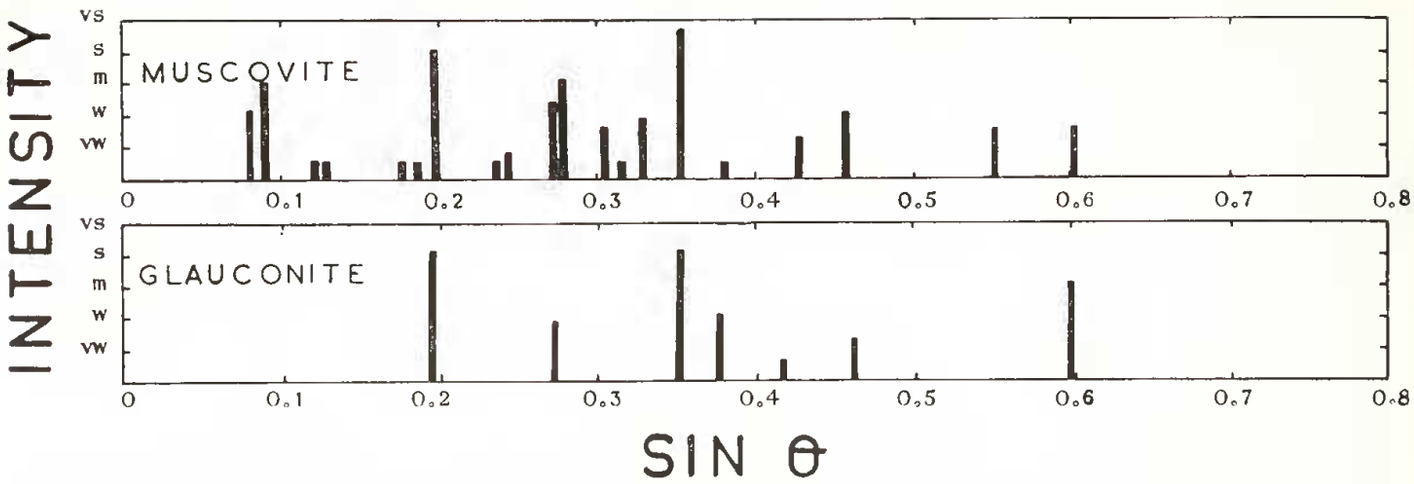

Fig. 2.—Graph showing the X-ray powder patterns of glauconite and muscovite from U.W.A. Specimen 46759. The pattern of muscovite has many weak reflections not present in the glauconite pattern because of diffusion.

micas. In the present investigation hand-picked samples of glauconite and muscovite were X-rayed by the powder method. The overall similarity of the patterns (see Fig. 2) suggests that the glauconite of the spicular sandstones is structurally similar to the muscovite from which it is presumed to have formed. Many weak lines in the mica pattern are not present in the pattern produced by the glauconite. Gruner noted this in his work and concluded that such lines are absent in the glauconite pattern because of diffusion.

The vertical variation of composition of the sandstones shows that quartz and glauconite percentages vary in sympathy. Presumably an increase in the amount of quartz reflects an increase in the influx of detritals (including muscovite) into the bottom sediment. The additional mica due to such influxes would permit more glauconite to form than would do so otherwise.

Conclusions

The structural similarity of glauconite and muscovite is illustrated by the similarity of the powder patterns produced by pure samples of the minerals.

Reaction structures show the direct nature of the transformation of muscovite to glauconite. Studies of variations of percentage composition in vertical sections support the view that glauconite forms directly from muscovite.

Though much of the glauconite in the rocks has formed from muscovite, presumably during early diagenesis, it is not possible to say that all the glauconite formed in this manner. It is conceivable that some owes its origin to processes quite unrelated to those mentioned above.

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